Groundnut Rust (*Puccinia arachidis*) Management through Integration of Host Resistance with Fungicides at Babile, Eastern Ethiopia

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Abstract

The field experiment was carried out at Babile Research Sub-Station of Haramaya University in 2010 main cropping season to evaluate the efficacy of four fungicides (chlorothalonil at a rate of 0.2 kg-ha^{-1}, copper hydroxide at a rate of 2.3 kg-ha^{-1}, mancozeb at a rate of 0.25 kg-ha^{-1} and triadimefon at a rate of 0.5 kg ha^{-1}) on groundnut rust (*Puccinia arachidis*) development and grain yield. The experiment was laid out in a randomized complete block design (RCBD) in factorial arrangement with three replications. Two groundnut varieties were used for the experiment namely, Shulamith (susceptible) and Sedi (moderately resistance). The fungicide treatments resulted in different levels of disease severity on the two groundnut varieties used [i.e. Shulamith (susceptible) and Sedi (moderately resistant) varieties]. Plots sprayed with triadimefon had significantly ($p \leq 0.001$) lower level (257.37%-days) of AUDPCof groundnut rust than plots treated with other fungicides. Three times spray with triadimefon at a rate of 0.5 a.i. kg ha^{-1} at 15-day-interval proved to be the best groundnut rust management system giving the lowest disease parameters (AUDPC, PSI and DPR) and highest yield 1644.44 kg ha^{-1}. Four times spray with mancozeb at a rate of 0.25 a.i. kg ha^{-}1 at 10-day interval proved to be the second best fungicide in significantly reducing the disease. Percentage severity index (PSI), area under disease progress curve (AUDPC) and disease progress rate were negatively correlated with groundnut seed yield. Thehighest rust severity 67.65%and lowest yield 1014.60 kg-ha^{-1}were recorded on the unsprayed control shulamith plots. On Shulamith variety, rust severity of up to 67.65% and relative yield loss of 35.55% were recorded in unsprayed plots. Generally, the current research results indicate that effective management of groundnut rust and significant yield benefit can be obtained when triadimefon fungicide spray is started just before or at the onset of the disease and properly continued at 15-day interval for three times spray frequencies. Evaluation of some more fungicides for their efficacies against groundnut rust and their integration with other rust management options can increase production and productivity of the crop.

Keywords: *Arachishypogaea*, AUDPC, fungicide, groundnut, incidence, *Puccinia arachidis*, rust, severity, spray schedule, yield

Introduction

Groundnut (*Arachishypogaea* L.) is an important oilseed crop, grown throughout the tropical and subtropical regions between 40°S and 40°N of the equator and where the annual rainfall ranges from 500 to 1200 mm with an average daily temperature of higher than 20 °C. It is grown in over 100 countries in six continents, mainly in Africa, America and Asia, with a world production of 37.1 million metric tons with cultivation area of 23.11 million hectares (FAO, 2007). Groundnut is one of the four economically important oilseed crops in Ethiopia that include flax, noug and sesame and is largely produced in the eastern parts of the country (Getenet and Nigussie, 1992).

Groundnut plays an important role in the diets of rural populations, particularly children, because of its high protein (21-30%), fat (41-52%), and carbohydrate (11-27%) contents (FAO, 2004). It is also rich in calcium, magnesium, phosphorus, potassium, nicotinic acid, vitamin B_1, B_2, B_6, vitamin E and other vitamins. It is also a good source of lecithin present in the range between 0.5 and 0.7% in decorticated nuts. In eastern Ethiopia, mainly high quality edible oil is extracted from groundnut and cakes are made from the remaining residue.

The groundnut shell is used for fuel and as organic fertilizer in many regions. The haulms are nutritious and widely used for feeding livestock. Besides its superior food value, groundnut also provides a source of cash for resource-poor farmers. Groundnut earns foreign currency for Ethiopia where over 2 million US dollars was obtained in 1989 crop season alone (Adugna, 1992). With the current interest in export-oriented agriculture, the future groundnut market situation appears attractive and profitably promising for Ethiopia.

Despite its importance, the average national yield (about 1.2 t-ha^{-1}) of groundnut in Ethiopia is significantly lower than is potentially achievable (over 2.0 t-ha^{-1}) (Geremew and Asfaw, 1992). This large gap between actual and potential yields is due to several factors, including unavailability of seeds of improved varieties, poor soil fertility, inappropriate crop management practices, and insect pests and diseases. Soil-borne fungal diseases like charcoal rot (*Macrophomina phaseoli*), pod rot (*Pythium* spp.), stem rot (*Sclerotium rolfsii*) and root rot (*Rhizoctonia solani*) as well as foliar diseases are the major constraints that decrease the productivity of the crop in eastern Hararghe (Getenet*et al*, 2007). The major foliar diseases of groundnut caused by fungi include rust (*Puccinia arachidis* Speg.), late leaf spot (*Cercospora personata* (Berk. & Curt.) Ell. & Eve and early leaf spot (*Cercosporaarachidicola* Hori). Groundnut rust and late leaf spots are important diseases in India and most of the Semi-Arid Tropic (SAT) regions (Subrahamanyam*et al*., 1980). Foliage fungal diseases, especially leaf rust and Cercospora leaf spots, result in severe yield losses in groundnut production areas of Ethiopia. Leaf rust causes yield reduction of up to 65%, especially in areas with high rainfall (Geremew and Asfaw, 1992).

Districts in eastern Ethiopia (Babile, Gursum, Fedis and Harar) are traditional groundnut growing-areas at large scale . Rust occurs every year in many parts of eastern Ethiopia that are food insecure and affects the livelihood of farmers (Getenet*et al*., 2007). Foliar applications of fungicides have been reported to markedly reduce rust development (Mayee, 1983).To this effect, it is important to seek suitable solution to the groundnut rust problem through fungicide applications. Therefore, this study was designed and carried out with the specific objective to evaluate the effect of fungicide sprays on groundnut rust development and yield.

Materials and Methods

Description of the Study Site

The field experiment was conducted at Babile Research Sub-Station of Haramaya University located at 555 km from Addis Ababa in East Hararghe Zone in 2010 main cropping season. The Research Station is located at 9°08'40''N latitude and 42°21'30''E longitude at an altitude of 1650 m a.s.l. The area is characterized by bimodal rainfall pattern occurring mainly during March to May and July to October, with an average annual rainfall of 671 mm and a mean temperature of 22 °C. The average annual temperature data for Babile shows a maximum and a minimum temperature of 28.05 °C and 15.52 °C, respectively. The type of soil at Babile Research Sub-Station is a well-drained sandy-loam with pH 7.0, organic matter 1.9% and available phosphorus 3.2 ppm (Abdi, 2004).

Evaluation of effects of fungicides on groundnut rust and yield

The experiment was conducted to evaluate the efficacy of four foliar fungicides to manage groundnut rust at Babile Research Sub-Station of Haramaya University during 2010 main cropping season.

Treatments, experimental procedures and design

A 2 x 5 factorial combination of two groundnut varieties, namely Shulamith (susceptible) and Sedi (moderately resistant) and four fungicides (chlorothalonil at a rate of 0.2 a.i. kg-ha^{-1}, copperhydroxide at a rate of 2.3 a.i. kg-ha^{-1}, mancozeb at a rate of 0.25 a.i. kg-ha^{-1}and triadimefon at a rate of 0.5 a.i. kg-ha^{-1}) along with non-treated control were arranged in a randomized complete block design (RCBD) with three replications. Three of the four fungicides were contact type and one was systemic type. The plot size was 5 m x 2 m (i.e. 10 m^2) and there were five rows per plot, and five plants per row were taken from the central three rows; hence 15 plants per plot were tagged for data recording. The distance between plots was 60 cm, while the distance between adjacent blocks was 1 m and row-to-row distance was 35 cm and plant-to-plant distance was 25 cm. Planting was done on 30April 2010 by dropping two seeds per hole and the less vigorous seedlings were thinned out later on. Weeding and all other recommended agronomic practices were done as required

Fungicide sprays

Foliar spraying of the fungicides was started 7 days before the first disease assessment (78 days after planting, DAP), i.e. when the first symptoms of the disease appeared. Three of the four fungicides namely, chlorothalonil copperhydroxide and mancozeb were sprayed at ten day interval while the systemic fungicide i.e, triadimefon was sprayed at 15 days interval. Spraying was performed by using a knapsack sprayer and plastic sheet was used as a shield during fungicide spraying to separate the plot being sprayed from the adjacent plots to prevent inter-plot interference of spray drift. Unsprayed plots were left for each groundnut variety as control.

Disease assessment procedures

Disease incidence was recorded two times (78 and 85 DAP) based on the first appearance of the disease symptoms. Disease severity was recorded seven times at seven-day interval by visual estimation of the percentage leaf area diseased. The disease severity estimates were rated using 1-9 disease scale (Subrahmanyam *et al.*, 1995). Disease severity scores were then converted into percentage severity index (PSI) for the analysis using the formula stated below (Wheeler, 1969).

$$PSI = \frac{SNR\ x100}{No.PS\ xMSS}$$

where SNR =Sum of numerical ratings, No.PS= number of plants scored and MSS= maximum score on scale

Data collected in the field

Disease data

Disease incidence was assessed by counting the number of plants showing rust symptoms on the central three rows of every plot in proportion to the total plants in the three rows and then converted into percentage. Disease severity was assessed by observing the percent tissue area affected by the disease on 15 tagged plants in the central three rows of every plot. Disease severity data were recorded using 1-9 disease scale (Subrahamanyam*et al.*, 1995). Severity was expressed as PSI computed based on 1-9 disease scale. Then the area under disease progress curve (AUDPC) was calculated for each plot using the formula developed by Shanner and Finney (1977) as follows.

$$AUDPC = \sum_{i=1} [(X_i + X_{i+1}) / 2][t_{i+1} - t_i]$$

where x_i is the cumulative disease severity expressed as a proportion at the ith observation (percentage of disease severity) t_i is time of the ith assessment in days from the first assessment date and n is the total number of assessments made.

Agronomic data

Stand count at harvest, number of pods per plant, number of seeds per pod, hundred seed weight, shelling percentage and yield in kg-ha^{-1} were recorded. Stand count at harvest was counted from the central three rows at harvest. Number of pods per plant was recorded from 15 tagged plants in the three central rows at harvest. Number of seeds per pod was recorded from the 15 tagged plants and five pods were shelled from each plant to find out the number of seeds per pod. Hundred seed weight was determined by measuring randomly picked 100 seeds from each plot using a sensitive balance. Shelling percentage was estimated as shell weight divided by dry pod weight multiplied by 100 usingl kg dry pod. Seed yield in kg-ha^{-1} was estimated from the middle three rows whereby all plants in the three rows were harvested and weight of seeds recorded. The seed yield was then expressed in terms of yield per hectare for statistical analysis.

Relative yield loss was also calculated based on the following formula (Robert and James, 1991): %RYL= [(YP-Yt)/YP] x 100

Where %RYL= relative percent yield loss, YP=yield from the maximum protected plot (sprayed treatment) Yt=yield from plots of other treatments including unsprayed control plots.

Data analyses

The percentage data on disease incidence and severity were subjected to ANOVA to determine the treatment effects. Mean disease severity from each plot was used in data analysis. Disease progress rate was obtained from the regression of PSI data fit to logistic model log^{e} (y/1-y) (Vander Plank, 1963) with date of assessments.

Correlation analysis was performed to determine the relationship between yield and AUDPC across the treatments. Data were analyzed by using Statistical Analysis System (SAS) Software Version 9.0.

Results and Discussion

Effects of fungicides on groundnut rust development and yield

The effects were evaluated using the disease parameters including disease incidence, disease severity, AUDPC, disease progress rate and relative yield loss.

Disease progress

In this study, disease progress was compared among the different fungicide treatments using percent severity index (PSI), area under disease progress curve (AUDPC) and disease progress rate (r). All these analytical methods were useful tools in quantifying disease epidemics.

Percent severity index (PSI)

Groundnut rust severity on the varieties Shulamith and Sedi at different DAP were estimated and depicted (Figure 1 and 2). There was significant ($p \leq 0.05$) difference between varieties on all dates of disease severity assessment. Mean PSI was higher in the susceptible variety Shulamith than the moderately resistant variety Sedi (Figure 1 and 2).The effect of foliar spray fungicides in reducing PSI was highly and significantly ($p \leq 0.001$) different in all dates of assessment. Moreover, the interaction effects of foliar spray fungicides and varieties were significantly ($p \leq 0.05$) different in reducing PSI after the second assessment date and thereafter. However, the fungicides sprayed had varying effects on groundnut rust severity. Plots sprayed with triadimefon at 15-day interval significantly reduced the severity of groundnut rust on both varieties. On the other hand, spraying triadimefon at 15-day interval and mancozeb at 10-day interval significantly reduced disease severity as compared to chlorothalonil, copperhydroxide and the unsprayed plot (Figure 1 and 2). However, none of the fungicide treatments completely controlled the development of the disease (Figure 1 and 2). Generally, the disease progress curves (Figure 1 and 2) showed higher disease progress in the two varieties (Shulamith and Sedi) on unsprayed plots than the sprayed ones. (Figure 1 and 2). According to Singh *et al.* (1981) triadimefon gave good control of rust on French bean in India, where it reduced the severity of French bean rust by 55%.

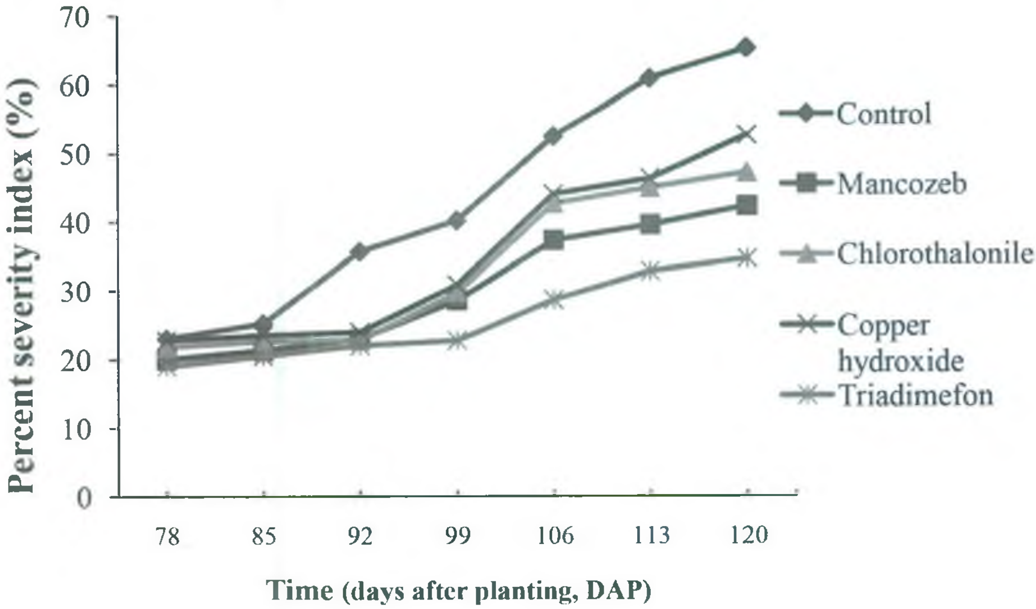

Figure 1: Groundnut rust disease progress curves showing percent severity index (PSI) as affected by different fungicide sprays on Shulamith variety at Babile during 2010 main cropping season

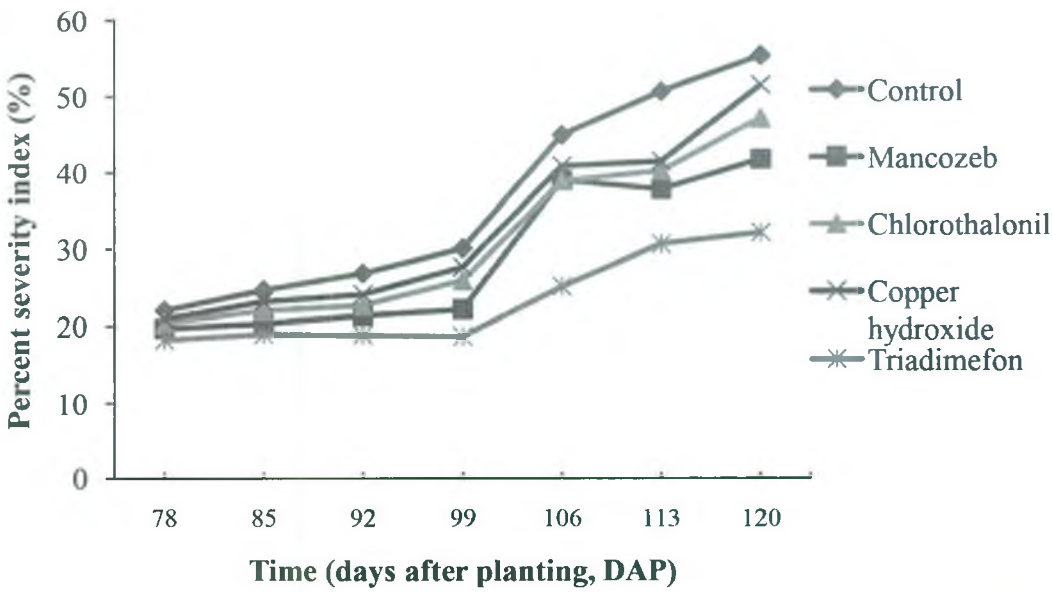

Figure 2: Groundnut rust disease progress curves in percent severity index (PSI) as affected by different fungicide sprays on Sedi variety at Babile during 2010 main cropping season

Area under disease progress curve (AUDPC)

Highly significant ($p < 0.001$) differences were observed in the magnitude of AUDPC among different foliar spray fungicides. The highest (353.37% days) AUDPC was obtained from the control (unsprayed plots) of Shulamith variety. This AUDPC value was significantly different from all the other fungicide treatments (Table 1), whereas the lowest AUDPC values (257.37% days and 243.37% days) were obtained on plots treated with triadimefon fungicide on Shulamith and Sedi varieties, respectively (Table 1).

The variety Shulamith treated with the fungicides triadimefon, mancozeb, chlorothalonil and copper hydroxide had AUDPC values of 257.37%-days, 268.85%-days, 306.44%-days and 312.29%-days, respectively (Table 1). The variety Sedi treated with the fungicides triadimefon, mancozeb, chlorothalonil and copper hydroxide had AUDPC values of 243.37%-days, 268.78%-days, 277.06%-days and 288.33%-days, respectively (Table 1). Moreover, interaction effect of varieties x fungicides was significantly ($p < 0.001$) different in reducing AUDPC.

The high degree of significant difference in AUDPC-values among the fungicide treatments indicated that fungicides had varying impacts on groundnut rust development.

Disease progress rate

Groundnut rust increased by 0.033 and 0.027 units each day on unsprayed plots of Shulamith and Sedi varieties, respectively (Table 1). This rate (0.033 unit per day) was reduced by four and three times on Shulamith plots sprayed with triadimefon and mancozeb, respectively (Table 1). On the other hand, the rust disease progress rate (0.027 unit per day) was reduced by four and two times on Sedi plots sprayed with triadimefon and mancozeb, respectively (Table 1).The overall mean disease progress rates of all the plots sprayed with different fungicides compared with unsprayed plots (control) were significantly ($p < 0.001$) different. Shulamith sprayed with triadimefon gave the lowest (0.004 unit per day) disease progress rate, while the untreated Shulamith (control) had the highest (0.033 unit per day) disease progress rate (Table 1).

Generally relatively lower disease progress rates were observed on plots treated with different fungicides than on untreated control plots and indicated that fungicide treatments were more effective in slowing down the disease progress rates than the rates on untreated plots. The results of the present study showed that disease progress rates were lower in plots sprayed with triadimefon fungicide at 15-day interval in both varieties (Shulamith and Sedi) than in plots treated with other foliar spray fungicides.

Yield and yield components

Seed yield

Significant ($p < 0.001$) variation was recorded on the seed yields obtained from plots that received different fungicide treatments (Table 2). Interaction of main effects (varieties vs. fungicides) was significantly ($p < 0.001$) different in seed yield (Table 2). The varieties Shulamith and Sedi plots sprayed with triadimefon gave high seed yield of 1644.44 kg-ha^{-1} and 887.41-ha^{-1}, respectively (Table 2). On the other hand, the unsprayed plots of Shulamith and Sedi gave low yield of 1014.60 kg-ha^{-1} and 748.53 kg-ha^{-1}, respectively (Table 2). On both varieties, the second highest yield (1543.94kg-$ha^{-1}$and 855.78kg-ha^{-1} was obtained from plots sprayed with mancozeb and the lowest yield (1014.60kg-$ha^{-1}$and 748.52kg-ha^{-1}) next to the control plots was obtained from plots sprayed with copperhydroxide (Table 2). The results follow the trend of disease development,i.e., treatments with high disease severity and AUDPC had high yield and vice versa. According to Scheinpflug and Kuck (1987), like most other sterol biosynthesis inhibitor (SBI) fungicides, triadimefon caused stronger plant growth regulatory side benefits on dicotyledonous plants, such as groundnut than on monocotyledonous plants.

Table 1: Mean levels of AUDPC and disease progress rates of groundnut rust following different fungicidetreatments at Babile in 2010 main cropping season

Groundnut Variety	Chemical	AUDPC[1]	DPR[2]
Shulamith	Chlorothalonil	306.44^{b}	0.025^{bc}
	Copper hydroxide	312.29^{b}	0.027^{b}
	Mancozeb	268.85^{de}	0.014^{de}
	Triadimefon	257.37^{ef}	0.004^{f}
	Control	353.37^{a}	0.033^{a}
Sedi	Chlorothalonil	277.06^{de}	0.016^{de}
	Copper hydroxide	288.33^{cd}	0.020^{cd}
	Mancozeb	268.78^{de}	0.012^{e}
	Triadimefon	243.37^{f}	0.002^{f}
	Control	324.08^{b}	0.027^{b}
LSD (0.05)		23.26	0.005
CV (%)		4.67	18.47

Values followed by the same letter within a column do not differ significantly according to Tukey's honestly significant difference test at $p \leq 0.05$

[1] AUDPC= Area under Disease Progress Curve, [2]DPR = Disease progress rate,

Table 2: Yield and yield components of groundnut treated with different fungicides on natural infections at Babile during 2010 cropping season

Variety	Chemicals	Yield and Yield Components						
		YPH (kg-ha^{-1})[1]	RYL (%)[2]	HSW(g)[3]	PPP[4]	SPP[5]	SCH[6]	SP (%)[7]
Shulamith	Chlorothalonil	1354.87^{c}	28.47^{bc}	49.80^{cd}	17.71^{c}	1.87^{b}	32^{cd}	68.33^{bc}
	Copper hydroxide	1255.23^{d}	30.78^{b}	48.36^{de}	16.35^{d}	1.83^{b}	31^{cd}	64.96^{de}
	Mancozeb	1543.94^{b}	21.47^{d}	54.43^{b}	19.64^{b}	1.85^{b}	37^{bc}	69.74^{b}
	Triadimefon	1644.44^{a}	0.00^{f}	58.16^{a}	24.64^{a}	1.84^{b}	43^{ab}	80.68^{a}
	Control	1014.60^{e}	35.55^{a}	42.63^{fg}	16.35^{d}	1.84^{b}	29^{d}	62.40^{ef}
Sedi	Chlorothalonil	797.50^{h}	21.15^{d}	40.50^{gh}	12.73^{f}	2.22^{a}	43^{ab}	61.90^{fg}
	Copper hydroxide	777.06^{i}	25.03^{cd}	38.13^{hi}	10.33^{g}	2.41^{a}	43^{ab}	59.24^{g}
	Mancozeb	855.78^{g}	7.64^{e}	45.43^{ef}	14.22^{e}	1.86^{a}	47^{a}	66.47^{cd}
	Triadimefon	887.41^{f}	0.00^{f}	51.93^{bc}	15.60^{d}	2.36^{a}	48^{a}	69.20^{bc}
	Control	748.52^{j}	35.46^{a}	37.03^{i}	10.02^{g}	2.25^{a}	44^{a}	55.15^{h}
	LSD(0.05)	5.64	4.38	2.99	1.22	0.29	7.09	3.03
	CV (%)	0.30	12.33	3.73	4.54	8.44	10.35	2.69

Values followed by the same letter within a column do not differ significantly according to Tukey's honestly significant difference test ($p \leq 0.05$).

[1] yield per hectare [3] hundred seed weight [5]seeds per pod [7]shelling percentage
[2] relative yield loss [4] pods per plant [6]stand count at harvest

Yield components

Stand count at harvest, number of pods per plant, number of seeds per pod, shelling percentage and hundred seed weight were highly and significantly different ($p < 0.001$) between varieties (Table 2). Moreover, significant ($p < 0.001$) variation was obtained among different foliar spray fungicides in all yield components (Table 2). Plots of Shulamith and Sedi varieties sprayed with triadimefon had higher stand count at harvest, number of pods per plant and hundred seed weight than unsprayed plots (control) (Table 2). Shulamith plots sprayed with triadimefon had higher (58.16 g) hundred seed weights than the unsprayed plots (42.63 g) (Table 2). But, on Shulamith variety, the hundred seed weight obtained from chlorothalonil-sprayed plots was significantly ($p < 0.001$) different from that of plots sprayed with copper hydroxide (Table 2). Besides, the number of pods per plant obtained from copper hydroxide sprayed Shulamith plots was not significantly different from the unsprayed plots (control). Generally experiments on fungicidal control of rust were conducted in many countries in the semi-arid tropics and largely increased seed yield and pods per plant were obtained (Littrell and Smith, 1980).

Relative yield loss

The highest seed yield (1644.44 kg-ha^{-1}) on Shulamith and 887.40kg-ha^{-1} on Sedi were obtained when the varieties were sprayed with triadimefon. The yield loss that was incurred by using one of the fungicide sprays was calculated relative to the yield of maximum protected plots and it varied among the different fungicides on the control (Table 2). Higher yield loss (35.55%) occurred on Shulamith unsprayed (control) plots (Table 2). Similarly, higher yield loss (35.46%) occurred on Sedi unsprayed (control) plots (Table 2).The second highest yield loss (25.03% and 30.78%) was obtained from plots sprayed with copper hydroxide fungicide in Sedi and Shulamith varieties, respectively (Table 2). However, on Shulamith and Sedi the second least yield loss (21.47% and 7.64%) occurred on mancozeb treated plots, respectively (Table 2). Furthermore, the third yield loss of 28.47% and 21.15% occurred when Shulamith and Sedi plots, respectively, were sprayed with chlorothalonil (Table 2). This would mean that in cases when triadimefon is not available mancozeb could be the second choice.

Association of disease parameters and yield of groundnut

Correlation analysis of yield with severity, AUDPC and disease progress rate revealed the existence of significant relationships among the different parameters (Table 3). Percent severity index (PSI) was negatively ($r=-0.91$) correlated to yield that indicated high negative effect of rust on groundnut yield (Table 3). AUDPC and disease progress rate were also negatively ($r= -0.85$ and -0.64) correlated, respectively, with yield (Table 3) while, percent severity index and AUDPC were more significantly and positively ($r = 0.92$) correlated. Similarly, percent severity index was positively ($r = 0.71$) correlated with disease progress rate (Table 3). On the other hand, the correlations observed among disease parameters (severities, AUDPCs and disease progress rates) were all positive. The investigation indicated that when PSI increased, the others (area under disease progress curve and disease progress rate) also steadily increased, while the disease progress rate was expected to slow down after the disease reached highest severity levels. It is a well-established fact that the availability of healthy plant tissue for infection limits the further development of epidemics; as epidemics progresses less plant tissue will be available for further infection and the rate of epidemic development (Freedman and Mackenzie, 1992).

Table 3: Correlation coefficients (r) between seed yield and disease parameters at final disease assessment (120 DAP[1]) of groundnut treated with different fungicides on natural infections at Babile during 2010 cropping season

	YPH(kg-ha^{-1})[2]	PSI[3]	AUDPC[4]	DPR[5]
YPH(kg-ha^{-1})	-------			
PSI	-0.91**	-------		
AUDPC	-0.85**	0.92***	-------	
DPR	-0.64*	0.71*	0.73**	-------

[1]Days after planting *= significant ($p \leq 0.05$), ** = highly significant ($p \leq 0.01$),*** = very highly significant ($p \leq 0.001$).
[2] Yield per hectare, [3]percent severity index, [4] area under disease progress curve and [5] disease progress rate

Summary and Conclusions

Groundnut is one of economically important cultivated oilseed crops, together with noug, flax and sesame in Ethiopia. It is largely produced in the eastern part of the country. Leaf rust of groundnut, which is caused by *Puccinia arachidis*, is the most common and economically important foliar disease of the crop. However, there is little research effort directed to develop suitable methods for its management. In this study four fungicides viz. chlorothalonil, copperhydroxide, mancozeb and triadimefon, were evaluated. Based on the findings of this study, it can be concluded that groundnut rust is an important disease that calls for due attention in the study area for effective and efficient management with fungicides and resistant varieties. Thus, three times foliar sprays with triadimefon at a rate of 0.5 a.i. kg-ha^{-1} starting right after the appearance of the rust at 15-day interval could manage the disease better than the rest of the fungicides. Hence, we recommend that suitable fungicides should be applied as soon as the first rust pustule appears. Even if an effective fungicide is found in this study, further studies should be conducted to workout effective and economical management options for the rust disease under different ecological situations and thereby to enhance high quality groundnut production in Ethiopia.

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